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PRODUCTION OF OIL FROM PLANT MATERIAL

By Professor E. BERL

CARNEGIE INSTITUTE OF TECHNOLOGY

INTERESTING information is given about the oil situation in this country in the excellent article by Dr. P. K. Frolich,¹ past president of the American Chemical Society. Dr. Frolich states that the time is not far off when oil products should be obtained from sources other than natural oil, for example, by the hydrogenation of coal or carbon monoxide produced from coal or from natural gas or from oil shales. Not all experts in this field agree with statements about the coming scarcity of oil within the boundaries of the United States.²

In previous communications to SCIENCE,³ I have stated that carbohydrates which are contained in farm products, wood, algae, etc., and which are formed by nature in enormous amounts and with greatest ease (see Table 1) can be converted into liquid fuel.⁴

¹ P. K. Frolich, SCIENCE, 98: 457, 484, 1943.

² W. Pratt, *Oil and Gas Jour.*, January 30, 1944, p. 78.

³ E. Berl, SCIENCE, September, 1934, and January, 1935.

⁴ J. G. Lippmann, *Ind. Eng. Chem.*, 27: 105, 1935.

According to such statistics, at the present rate of oil extraction, the cheap oil in this country would be gone in about fourteen years; therefore, it is imperative

TABLE 1

Plants	2.7×10^{11}	metric tons of C content
Annual production of cellulose and other carbohydrates	3×10^9	" " " "
Crude oil reserves in U. S. A.	2.64×10^9	" " " "
Crude oil reserves in world	4.4×10^9	" " " "
Annual oil production U. S. A.	1.93×10^8	" " " "
Annual world oil production	2.94×10^8	" " " "

that ways and means should be used in order to allow a continuous production of liquid fuel after the exhaustion of that oil under ground which can be recovered at relatively small cost.

One can get from cornstalks, corn cobs, sugar-cane, bagasse, seaweed, algae, sawdust, Irish moss, molasses, sorghum, grass or any other carbohydrate-containing

material by a controlled internal combustion a material called "protoproduct." This protoproduct contains about 30 per cent. of phenol carbonic acids, 4.5 per cent. phenols and 63.5 per cent. neutral material. It is semi-liquid at room temperature and liquid at somewhat higher temperatures. It contains about 60 per cent. of the carbon content of the original plant material. This "carbon" yield is practically identical with the yield which one gets when water-soluble carbohydrates are converted into alcohol by fermentation. The yield in K cal (BTU)—thermal efficiency—for the conversion of plant material into liquid fuel is rather high. One long ton of dry sugar-cane (4.33×10^6 K cal "upper" heating value and 3.97×10^6 "lower" heating value)⁵ contains .5 tons C. With a 60 per cent. carbon conversion, .375 tons of protoproduct (with 80 per cent. C) result which produce 3.28×10^6 K cal "upper" or 3.09×10^6 K cal "lower" heating value. The thermal efficiency is therefore 75.6 and 77.7 per cent., respectively.⁶ A thermal efficiency of 76 per cent. based on oxygen-free material results if the protoproduct is hydrogenated and the asphaltic material discarded. The aforementioned "protoproduct" as a hydrophobic substance separates easily from the watery medium. No further concentration is nec-

hydrogenation or by cracking. Hydrogenation of the liquid protoproduct can be carried out much more simply than that of pulverized older lignites or younger bituminous coals. After hydrogenation about 45 per cent. of the original carbon content of, for instance, sugar-cane results as gasoline, kerosene and lubrication oil. Gasoline (boiling up to 200° C. or 392° F) contains 20 per cent. of aromatics. 17.4 per cent. of the original carbon content in sugar-cane are found in this gasoline. The kerosene fraction contains 19.7 per cent. of the sugar-cane carbon. It can be cracked to lower boiling hydrocarbons. The lubrication fraction with 7.6 per cent. of the carbon content in sugar-cane shows properties identical with that of lubrication oil obtained from natural oil. The remaining asphalt-like material with 15 per cent. of the sugar-cane carbon retains after hydrogenation a few per cent. of bound oxygen. It derives mostly from the lignin content of the plant. The asphaltic material can be used for purposes where natural asphalts are used, or it can be burned as is done with pitch.

Table 3 shows conversion results for sugar-cane of which in continental U. S. (Louisiana) 18.55 long tons and in Hawaii 33.2 long tons are produced per acre a year.⁷

TABLE 2

Material	Sp. wt.	K cal/kg.		BTU/lb.		K cal/liter		BTU/gal.	
		upper	lower	upper	lower	upper	lower	upper	lower
Protoproduct	1.14	8,736	8,250	15,725	14,850	9,960	9,405	119,580	141,263
100 per cent. ethanol.	.794	7,092	6,370	12,765	11,465	5,630	5,058	84,578	75,970
95 per cent. ethanol.	.809	6,737	5,984	12,127	10,771	5,450	4,841	81,860	72,712
Gasoline70	11,000	10,000	19,800	18,000	7,700	7,000	115,655	105,140

Upper heating values: Liquid water in the combustion gas.
Lower heating values: Water vapor in the combustion gas.

essary. Fermentation alcohol results as a diluted (5-8 per cent.) material which afterwards has to be concentrated to get industrial alcohol.

The protoproduct can be used as fuel oil or, with or without a simple treatment, in Diesel engines. Table 2 shows the superiority of the protoproduct (sp. wt. 1.14) over alcohol in its BTU (K cal) content per weight or volume unit.

About 50 per cent. of oxygen are contained in plant material, for example, in dry, ash-free sugar-cane. Protoproduct made from sugar-cane contains 20-10 per cent. of bound oxygen which can be removed by

⁵ The "upper" heating value is related to liquid water, the "lower" heating value to water vapor in the combustion products.

⁶ The remaining 24.4 per cent. thermal efficiency are found in the compounds contained in the watery liquid and in the gas. This high thermal efficiency of 75.6 (77.7) per cent., which does not include the relatively small amount of heat necessary for the conversion, may be compared with the 30 per cent. thermal efficiency in the coal hydrogenation plant in Billingham (see later).

Our generation is rather careless with those savings which nature put under ground many millions of years ago. We recover oil from underground often with low

TABLE 3

a. From 100 long tons dry sugar-cane result
2,980 gal. gasoline
3,430 " middle oil
1,210 " lubrication oil, or
8.45 long tons raw cane sugar (Louisiana)
10.0 " " (Hawaii)
b. From 100 long tons dry bagasse
(resulting from 110 tons dry sugar-cane)
2,550 gal. gasoline
2,950 " middle oil
1,020 " lubrication oil

yields.⁸ We use up this oil rather imperfectly in a very short time. Then it is gone forever. It would be wise and practical to use more and more agricultural

⁷ U. S. Department of Commerce, Statistical Abstract of United States, 1941.

⁸ Improved yields can be obtained with the use of the writer's U. S. Patent No. 2,267,548.

products for the production of liquid and semi-liquid fuel, and if necessary, of solid fuels. Nature produces per annum 3×10^9 tons carbon content in carbohydrate-containing material. The world consumption of oil at present is estimated to be 2.94×10^8 tons carbon content per year. The annually produced cellulosic plant material⁴ (see also Table 1) would allow the production of about six times the actual oil consumption with an overall carbon conversion of 60 per cent. and a thermal efficiency of 75.6 and 77.7 per cent., respectively.

Thirty million (3×10^7) cars on the U. S. highways in 1941, the last "normal" year in this country, consumed 5.56×10^7 long tons of liquid fuel. If this amount of liquid fuel were to be produced from sugar-cane, due to the lower yield per acre a year in the continental United States, 9.7×10^6 acres would be needed, and with a sugar-cane production per acre a year as in Hawaii, Puerto Rico, Philippine Islands and Cuba, 5,420,000 acres would have to be planted with sugar-cane. These figures are based on the conversion to protoproduct only. If this protoproduct were converted into oxygen-free gasoline, then for continental U. S. 1.32×10^7 and in countries with a climate similar to that of Hawaii, 7.37×10^6 acres would be needed. In the last figures, the amount of raw material necessary for the deoxidation of the

in Hawaii.⁷ From dry sugar-cane, bagasse (Table 3) or other crops, interesting amounts of protoproduct and oxygen-free liquid fuel can be obtained. In using these, one would not use up the present oil reserves with dangerous speed. One would not consume coal of which about five tons are necessary to produce one ton of liquid fuel (this corresponds to 30 per cent. thermal efficiency) and one would not run into difficult transportation problems which are connected with the use of oil shale and disposal of distilled material. Oil shale allows the production of 30-70 gallons of oil with .90-.77 tons of valueless residue per ton of shale.

The total production of sugar-cane in Hawaii, Puerto Rico, Philippine Islands and Cuba which have practically the same climate and, therefore, the same production of sugar-cane in long tons per acre a year can be seen from Table 5.

TABLE 5

Hawaii	7.83×10^6
Puerto Rico	7.83×10^6
Philippine Isl.	9.4×10^6
Cuba	35.2×10^6
	60.26×10^6

From these four countries one could produce 1.8×10^7 tons of liquid fuel, which is nearly one third of the consumption in 1941 for the 30,000,000 cars. The

TABLE 4

ANNUAL PRODUCTION FIGURES FOR CONTINENTAL U. S. AND FOR HAWAII FOR 1937-1940⁷ AND CONVERSION FIGURES INTO OIL

	Total acreage harvested for sugar cane and seed	Total product. of sugar- cane and seed long ton	Long ton sugar- cane/ acre	Raw sugar long ton	Raw sugar long ton/ acre	Long ton raw sugar/ long ton cane	Long ton proto- product per acre	Barrels proto- product per acre	Long ton proto- product by total conversion of sugar- cane	Barrels proto- product by total conversion of sugar- cane
Continental U. S.	2.92×10^8	5.01×10^6	18.55	4.24×10^5	1.45	.085	5.565	30.7	1.625×10^6	8.96×10^7
Hawaii	2.36×10^5	7.83×10^6	33.20	7.83×10^5	3.32	.10	9.96	55.0	2.35×10^6	12.98×10^7

protoproduct is not included. The cropland harvested in the U. S. amounts to 3.2×10^8 acres. The 9.7×10^6 and 1.32×10^7 acres in continental U. S. would correspond to 3.4 per cent. and 4.13 per cent. respectively of harvested land and 1.7 per cent. and 2.3 per cent., respectively, of the land available for crops (5.3×10^8 acres).

6.6×10^7 tons of liquid fuel—in other words, more than the 30,000,000 cars consumed in 1941—could be produced in the U. S. A. if the 2.6×10^8 tons of plant waste produced annually would be converted into liquid fuel.

In this country and more advantageously in countries with tropical climate, very large amounts of carbohydrate-containing material can be produced. Table 4 shows the yields per acre a year for sugar-cane crops (which allows the maximum carbohydrate production per acre a year) in the continental United States and

planting of sugar-cane in these and other tropical countries, for instance, Brazil, certainly could be multiplied provided there would be a use for the increased sugar-cane output.

9.7×10^7 acres planted with sugar-cane would be needed in the continental United States to produce the alcohol equivalent to 5.56×10^7 long tons of liquid hydrocarbon fuel. This compares with the above-mentioned 9.7×10^6 acres planted in continental U. S. necessary to furnish the fuel for 3×10^7 cars. Less than 10 per cent. of the sugar-cane content present as saccharose are converted into alcohol. With the process of the writer, altogether 70 per cent., which represents the total carbohydrate content of the sugar-cane, including cellulose, can be converted into liquid fuel.

The synthetic fuel production in Fortress Europe dominated by Germany is estimated to be 1×10^7 tons,

to which $4-5 \times 10^6$ tons of natural crude produced in Roumania, occupied Poland, Austria and Germany have to be added. In other words, the 1.8×10^7 tons of liquid fuel which could be produced from the present sugar-cane production in Hawaii, Puerto Rico, Philippine Islands and Cuba are 80 per cent. higher than Germany produces in her synthetic oil plants, in which certainly more than \$2,000,000,000 have been invested. Continental U.S.A. produces now 2.2×10^8 tons of crude oil.

That hydrogenation of coal with the Bergius-I. G. process and of carbon monoxide with the Fischer-Tropsch process is carried out on a large scale in Germany (10,000,000 tons per year) is not perfect proof that these processes under the present conditions is the only way to end the oil shortage for this and other countries. Great Britain has not enlarged her Billingham coal hydrogenation plant, with about 150,000 tons of oil products per year.⁹ Hydrogenation of coal and carbon monoxide can not be carried out without large government subsidies (6.65 cents per gallon on home-produced petrol in Great Britain).

Any synthetic method whatsoever must produce liquid and solid fuels at prices higher than the very low present prices of natural oil and bituminous coals in this country. Farish¹⁰ and Williams¹¹ gave data from which the high price of coal hydrogenation products can be seen (22.6 cents per gallon for gasoline with coal hydrogenation,¹⁰ 24.4 cents per gallon with carbon monoxide hydrogenation from coke,¹¹

19.2 cents from bituminous coal,¹⁰ 18.2 cents from sub-bituminous coal,¹¹ 18.2 cents¹¹ and 8.8 cents¹⁰ respectively from natural gas). Direct costs per gallon of gasoline are 15.9 cents for coal hydrogenation¹⁰ and 14.7 cents for carbon monoxide hydrogenation.¹⁰ 6.7 and 4.5 cents per gallon, respectively, have to be spent for 10 per cent. depreciation. The production of liquid and semi-liquid fuels from plant material, especially in tropical and subtropical countries, or where practically valueless wastes result, can be made at rather low prices provided the transportation problem does not offer special difficulties.

This plant conversion process has the great advantage that it does not touch the materials underground. In this and other countries the farmer must produce more raw materials for industrial purposes. In smaller installations, plant material could be converted into the fuel which is necessary for his tractors and for heating his home. This can not be done by the coal hydrogenation which, according to our present knowledge, must be carried out in large and very costly installations.

The plant conversion process puts liquid fuel at the disposition of practically all civilized nations. Any country which is not blessed with natural oil and which has or can develop an adequate agricultural or forest production can now produce an important part of its liquid fuel needs.

The author expresses his thanks to A. Schmidt, H. Biebesheimer, W. Dienst, A. B. Cramer, H. Heine-mann and D. Myers for their valuable collaboration.

OBITUARY

MEMORIAL TO FRANK LEVERETT

ON November 15, 1943, after an illness of only a few weeks, Frank Leverett passed away at his home, 1724 South University Avenue in Ann Arbor, Michigan, at the age of 84 years. Until the time of his last illness he was active in researches dealing with glacial geology, a field in which he had gained a most enviable and world-wide reputation.

Frank Leverett was born at Denmark, Iowa, on March 10, 1859, the son of Ebenezer Turner Leverett and Rowena (Houston) Leverett. He was descended from a line of ancestors that emigrated from Boston, England, to Boston, Massachusetts, in 1663.

Upon completion of his academic training in Denmark Academy, Leverett taught in the public schools

during 1878-1879. For three years following, until 1883, he served as instructor in natural sciences at Denmark Academy. It was in this position, while conducting field excursions with his classes, that he first became interested in the study of geology. In the fall of 1883 he entered Colorado College, where he took courses in mineralogy and assaying. In 1884 he enrolled in Iowa State College of Agriculture and Mechanic Arts and was graduated from that institution with a degree of bachelor of science in 1885.

Following his graduation from Iowa State College, Leverett journeyed on foot to Madison, Wisconsin, to confer with T. C. Chamberlain, then president of the university, concerning the possibility of obtaining a job on the U. S. Geological Survey. Being director of the Division of Glacial Geology in the Federal Survey, Chamberlain made an opening for young Leverett and assigned him to a temporary job as field assistant in glacial geology. Inspired by this opportunity to engage in a field of work which seemed to satisfy completely his cravings for scientific adventure, Leverett

⁹ W. A. Bone and G. W. Himus, *Coal, Its Constitution and Uses*, 1936, p. 556.

¹⁰ W. S. Farish, Committee on Mines and Mining, House of Representatives, July 15, 1942.

¹¹ J. P. Williams, Subcommittee on War Minerals of the Committee on Public Lands and Surveys, U. S. Senate, August 6, 1943 (Pittsburgh).

gave such a good account of himself that he was continued as an assistant until 1890, when he was appointed to the position of assistant geologist on the Survey. In 1901 he was advanced to geologist and in 1928 to senior geologist, a position which he held until his retirement in 1929.

During his forty-three years of continuous service with the U. S. Geological Survey, Leverett's achievements in the field of glacial studies gained for him world-wide recognition as one of the leading authorities on Pleistocene glaciation. He was an indefatigable investigator and never ceased to take a whole-hearted and genuine interest in the problems connected with that field of science.

Leverett spent the year 1908 in Europe, where he became personally acquainted with many of the leading glacialists on the continent. His numerous excursions into the glaciated tracts abroad gave him an opportunity to draw comparisons between the glacial deposits of Europe and those of North America which, through a long period of years, he had covered so thoroughly on foot or by means of horse and buggy.

Frank Leverett was twice married. His first wife was Frances E. Gibson, whom he married in 1887. In 1895, several years after her death, he was married to Dorothy C., daughter of Russell and Dorothea (Schmidt) Park, who survives him. There were no children by either marriage.

For a period of twenty years, from 1909 to 1929, Leverett served as a special lecturer in glacial geology on the staff of the University of Michigan. He was a skilful and resourceful teacher, greatly beloved by his students. He drew freely upon his great wealth of knowledge gained from personal experience and was able to make the subject of glaciation a most attractive study. He took great interest in his students, old and young alike, and never grew tired explaining over and over again perplexing problems that to him were nothing more than simple principles, so well did he know them. Following his retirement from active service with the U. S. Geological Survey, the University of Michigan conferred upon him the honorary degree of doctor of science in 1930.

Leverett was elected a fellow of the Geological Society of America in 1891, the year after its founding. In 1910 he served as the second president of the Michigan Academy of Science, Arts and Letters and subsequently contributed many valuable papers during his long membership in that organization. He was honored with election to membership in the American Philosophical Society in 1924. He was a fellow of the American Association for the Advancement of Science and served as its vice-president during 1928. In 1939 he was elected to membership in the National Academy of Sciences. He was a member also of the Science

Academies of Iowa, Wisconsin and Washington (D. C.), the Forestry Association, the Geophysical Union, and served as a corresponding member of the National Geographic Society. He held memberships in the honorary fraternities of Phi Kappa Phi and Sigma Xi.

Frank Leverett was a prolific writer. His bibliography lists some 170 titles in the form of reports, water supply papers, bulletins, monographs, professional papers and miscellaneous papers published in the period between 1889 and 1943. The greater part of these pertain to problems in Pleistocene geology and water resources. Outstanding as a classic is his Monograph 53 (with Frank B. Taylor), "The Pleistocene of Indiana and Michigan and the History of the Great Lakes," published by the U. S. Geological Survey in 1916.

Leverett spent a lifetime doing a big job well. His critical interpretations of natural phenomena and his masterful portrayal in writing of his observations marked him as a truly great scientist. He learned his facts first hand and spared no effort in making certain that he understood the meaning of the features he observed before he translated them into his published writings. He considered his work in the field of glacial geology as merely an open door to a vast multitude of problems that should engage the efforts of glacialists for generations to come.

Leverett's private study in his home in Ann Arbor was an open classroom to an almost endless procession of geologists who sought his expert advice and counsel. He seemed to have a peculiar personal concern for the younger geologists and would spend hours assisting them with their problems. He took special delight in recounting the highlights of his personal travels and experiences.

A great scientist, a masterful teacher, but in all a modest man of remarkable wisdom, Frank Leverett will be remembered by all who knew him for his great love of glacial geology. His works will stand as an enduring monument to a lifetime of purposeful achievement.

STANARD G. BERGQUIST

MICHIGAN STATE COLLEGE

DEATHS AND MEMORIALS

JESSE PAWLING, from 1925 to 1935 associate astronomer at the U. S. Naval Observatory in Washington, D. C., died on April 11 at the age of seventy-eight years. Mr. Pawling graduated from Cornell University in 1893 and after several years of graduate work in other universities and teaching physics in Philadelphia, he went to the Naval Observatory in 1905, where for thirty years he worked on positional astronomy.

WILLIAM TITUS HORNE, professor of plant pathol-

ogy at the University of California, plant pathologist at the Citrus Experiment Station at Riverside, died on April 12 at the age of sixty-seven years.

DR. JOHN L. ROSE, for the past fifteen years an instructor in physics at New York University and supervisor of the laboratory of physics, who recently joined the War Research Division of Columbia University, died on April 13 at the age of forty-seven years.

DR. ARTHUR ERNEST JOLLIFFE, until his retirement with the title emeritus in 1936 professor of mathematics at King's College, London, died on March 17 at the age of seventy-three years.

THE Board of Governors of the Institute of Medicine of Chicago has accepted the custody of a memorial fund collected by friends and associates of Sergius

Arquin, who died while an intern at Cook County Hospital. The income from the fund is to be used as a prize for investigative work or as a contribution toward the cost of publication or illustration of such work or for related assistance in clinical research carried on by an intern or resident in Cook County Hospital or other local hospitals. Applications should be addressed to the Secretary of the Institute of Medicine of Chicago, 86 East Randolph Street, Chicago 1.

A PLAQUE will be unveiled on May 24 to the memory of Samuel F. B. Morse on the day when he sent the first telegram from Washington to Baltimore one hundred years before. The plaque will be unveiled near the old Supreme Court room with a re-enactment of the scene in 1844 when Morse sent the first telegram over an experimental line to Baltimore. The original instrument is being loaned by Cornell University.

SCIENTIFIC EVENTS

THE SOVIET WORLD ATLAS

The Scottish Geographical Magazine writes as follows in regard to the World Atlas of the U.S.S.R.:

In the judgment of competent authorities this is the finest atlas which has ever been published. It is to be published in three parts: Part I is already issued, but Parts II and III, which were to have been issued in 1940, have been held up owing to the war.

The scholarship is thorough and the reproduction outstanding. The plates are beautifully printed by offset presses, and many of them use fifteen or twenty colors. The paper is rag stock and there is a special binding which makes it possible to remove individual maps. Editorial work cost five million roubles, while publication cost twenty million roubles more.

Volume I deals with the world as a whole and the Soviet Union as a whole. Some of the outstanding plates are the world maps of soils, natural vegetation, trade, national ownership of railways, population and mineral resources. There is a new climatic region map specially revised by Koeppen. A wealth of material also throws light on the resources of the Soviet Union. Many maps are double and triple page size.

Since the atlas is in Russian its use has naturally been very limited, but the Department of Geology and Geography of Syracuse University, New York, has come to the rescue and, with the assistance of two of their staff especially, have translated into English all the titles and legends of Volume I. These are now available in a litho-printed book of 100 pages. Place names are not generally translated, but they are not considered essential, as the atlas deals largely with economic, cultural and physical aspects. No knowledge of Russian is needed to use the translation volume, as the appropriate symbol is shown opposite each item in the legend.

Volume II and Volume III, not yet published, deal,

respectively, with the Soviet Union in detail and with foreign countries.

THE MAP OF JAPAN OF THE NATIONAL GEOGRAPHIC SOCIETY

THE National Geographic Society has issued a map of Japan and adjacent regions. The exact mileage to Tokyo from the recently won island bases appearing on the edges of this map can be accurately measured. It is published as a ten-color supplement to the April issue of *The National Geographic Magazine* and is the most comprehensive general chart of Japan, eastern China, Manchuria and eastern Soviet Russia so far produced.

The map has been computed with Tokyo as its center. The exact spot is the central railway station, about which cluster the Imperial Palace, the Central Post Office and the Marunouchi Building, one of the city's largest office structures.

There are five large-scale insets—close-ups of industrial and strategic areas. These include the Tokyo-Yokohama-Yokosuka Navy Base region; the Nagoya manufacturing center; the tri-cities of Osaka, Kyoto and Kobe; the Shimonoseki area, where Honshu and Kyushu are joined by a railroad tunnel at the western end of the Inland Sea, Japan's Mediterranean, and the naval centers of Sasebo and Nagasaki. A sixth inset shows the entire Marshall Islands group, including American-held Kwajalein, Eniwetok, Wotho and Majuro atolls.

Railroads and roads are shown, recent dismantling due to the war is noted, and projected construction indicated. The usual table of geographic equivalents translates foreign-spelled geographic names into Eng-

lish. Chinese place-name spellings correspond with news dispatch usage.

The map was compiled from entirely new base material, and was welcomed by the Geographical Section of the General Staff, the Far Eastern Division of the Commerce Department and other Government offices which opened their files so that all information that had been collected might be put into usable form.

GRANTS OF THE ROCKEFELLER FOUNDATION FOR FUNDAMENTAL RESEARCH IN EUROPE

THE review for 1943 of the Rockefeller Foundation by President Raymond B. Fosdick includes the following account of its work in support of research in Europe:

It is gratifying to record that even in the war-shaken countries of Europe fundamental research in the biological and medical sciences has been kept alive. Nothing is known, of course, of the situation in Germany and in most of the occupied countries; but in Great Britain, in Sweden, in Switzerland and until recently in Denmark work on basic problems had been prosecuted without serious break.

In relation to many of these projects the Rockefeller Foundation has been able to be of assistance. Ever since the war started, uninterrupted support has been given, for example, to Svedberg's monumental work on proteins at the University of Uppsala and to Runnström's research in chemical physiology and embryology at the University of Stockholm. Dr. Svedberg is a Nobel prize winner, and the studies of both these men have deep significance for the future. In the earlier days of the war it was possible for the foundation to get funds to outstanding Danish scholars working at the University of Copenhagen. When these scholars were driven out of Denmark, support was continued for them in Sweden, where they had found refuge.

Similarly, aid to Swedish scholars has been given during the war for research in biochemistry, biophysics and neurophysiology at the Karolinska Institut; for studies in radiology at the Serafimer Hospital; and for work in radioactive substances at the Research Institute of Physics of the Academy of Sciences. In Switzerland the foundation has made grants to the University of Basel, the University of Zurich and the Eidgenössische Technische Hochschule for research in biochemistry, organic chemistry and plant physiology.

In Great Britain, grants—in relatively small amounts—cover a wide range of basic research in biochemistry, biophysics, genetics, organic chemistry, psychiatry, neurology and neurosurgery. This research is under way at Oxford, Cambridge, the University of Sheffield, the University of Edinburgh, the University of Birmingham, the Galton Laboratory and University College, London.

But it is not alone in the biological and medical sciences that these war-weary countries are maintaining the studies and research that look to the future and are thus keeping alive in Europe the high tradition of learning. In the social sciences as well a great deal of work is being car-

ried on; and since the war began the foundation has had the privilege of making grants to organizations like the Royal Institute of International Affairs, the London School of Economics and Political Science, the National Institute of Economics and Social Research in London, the Social Studies Research Committee of Oxford, Political and Economic Planning (PEP)—as well as to the Swedish Institute of International Affairs and the Graduate Institute of International Studies at Geneva, Switzerland.

Sums have also been given to the delegates of the press of Oxford University for distribution as grants in aid among refugee scholars in England in connection with their research. The reports from Oxford indicate that the research has covered widely diverse fields, such as philosophy, history, mathematics, music, art and law. "I can give an excellent account of the industry, frugality and loyal spirit of those who have received grants," writes Kenneth Sisam, who has been in charge of the fund. "It is a scheme which has enabled scholars who could not take an active part in war work to make a valuable contribution to learning."

That fundamental research can be maintained in countries where the shock of war is ever present, and the lamp kept burning, is in these dark days a refreshing reminder of the power and persistence of creative intelligence.

THE VIRGINIA ACADEMY OF SCIENCE

THE twenty-second annual meeting of the Virginia Academy of Science will be held at Richmond on May 9 and 10. Seven of the eleven sections of the academy will hold meetings, including the sections of bacteriology, biology, chemistry, education, geology, physics and mathematics and statistical methods. It is expected that about seventy-five papers will be presented, many of them reporting the results of research during the past year.

At the evening session on May 9, after a dinner for members of the council, section officers and committee chairmen, the names of those to whom have been awarded the annual research prize for members and the Jefferson award will be announced. Officers for the coming year will be elected. Dr. Robert F. Smart, professor of biology and chairman of the Division of Sciences of the University of Richmond, will be installed as president.

Meetings of the sections will be held on May 10 beginning at 10 A.M. There will be a luncheon at 1 o'clock, during which the reports of the outgoing president and of the secretary of the academy, Dr. E. C. L. Miller, will be read. Following the meetings of the sections the Virginia Section of the American Chemical Society will give a dinner. An evening meeting has been arranged at which Dr. E. H. Hamann, chief chemist for Fritzsche Brothers, New York City, guest lecturer, will speak on "The Production of Essential Oils in Various Countries." All members of the academy and the public are invited.

THE NATIONAL SCIENCE TEACHERS ASSOCIATION

THE formation of The National Science Teachers Association, "to stimulate, improve and coordinate science teaching at elementary, secondary and collegiate levels of instruction" has been announced by Dr. Philip G. Johnson, assistant professor of rural education at Cornell University, *president pro tem* of the new organization.

The association has been formed as the first step in a merger of two national science teachers organizations—the American Science Teachers Association and the American Council of Science Teachers. It is expected ultimately to have more than twenty-five thousand members representing all teachers of science. It will be affiliated with the American Association for the Advancement of Science and with the National Education Association.

Its general aims are:

To make the influence of science teacher organizations a potent force through the unification of their efforts.

To initiate and maintain a national effort by scientists and educators to the end that the sciences may be given a just and reasonable opportunity to serve the needs of all youth and adults.

To plan a long range program for the improvement of the teaching of science.

To assist scientists and science teachers to work together and have a voice with other groups, such as teachers in other subject matter fields, supervisors and administrators, in defining plans and policies for public education.

To stimulate wide-spread and intelligent cooperative action on problems related to the teaching of science.

The preliminary organization, which is to hold office until the merger is completed, or until December 31, 1944, was developed at a recent meeting in Pittsburgh, participated in by leaders of eleven national and regional groups interested in the advancement and improvement of the teaching of science.

Participating were Norman R. D. Jones, of St. Louis, president of the American Council of Science Teachers; Dr. Morris Meister, of New York City, president of the American Science Teachers Association; Emil L. Massey, of Detroit, president of the Central Association of Science and Mathematics Teachers; Professor Hugh C. Muldoon, of Pittsburgh, of the Catholic Conference of Science Teachers; M. A. Russell, of Royal Oak, Mich., president of the Na-

tional Association of Biology Teachers; Dr. Reuben T. Shaw, of Philadelphia, of the Middle States Association of Science Teachers; W. H. Michener, of Pittsburgh, of the American Association of Physics Teachers; John C. Hogg, of Exeter, N. H., of the New England Association of Chemistry Teachers; Dr. Dwight E. Sollberger, of Indiana, Pa., of the American Nature Study Society; Laurence L. Quill, of Lexington, Ky., of the Division of Chemical Education of the American Chemical Society, and Dr. Johnson, of Cornell University and the Ithaca Public Schools, *president pro tem*.

Membership in the association will be open to all teachers of science, and to others interested. Provision is made for the affiliation of other groups. The headquarters of the association, for the present, will be at Cornell University.

MEDAL DAY OF THE FRANKLIN INSTITUTE

THE annual Medal Day ceremonies of the Franklin Institute of Philadelphia were held on April 19.

As already announced in *SCIENCE*, Franklin Medals were awarded to Dr. William David Coolidge, vice-president and director of research for the General Electric Company, and to Peter Kapitza, director of the Institute for Physical Problems of the Academy of Sciences, U. S. S. R.

The Francis J. Clamer Medal was awarded to Dr. Walther Emil Ludwig Mathesius, president of the Geneva Steel Company at Geneva, Utah, a former vice-president of the United States Steel Corporation, for "decidedly outstanding achievements in metallurgy and particularly for contributions in blast furnace practice."

Joseph Burroughs Ennis, senior vice-president of the American Locomotive Company, New York, received the George R. Henderson Medal for work in locomotive engineering and design.

Professor Stephen P. Timoshenko, of Stanford University, received the Louis E. Levy Medal for a paper entitled, "The Theory of Suspension Bridges," published in the journal of the institute.

Dr. Harvey Clayton Rentschler, director of research of the lamp division of the Westinghouse Electric and Manufacturing Company at Bloomfield, N. J., received the Frank P. Brown Medal "in consideration of his application of a source of bactericidal ultraviolet radiation in air conditioning systems."

SCIENTIFIC NOTES AND NEWS

DR. E. V. MCCOLLUM, of the School of Hygiene and Public Health of the Johns Hopkins University, is the first recipient of the Borden Nutrition Award

given by the American Institute of Nutrition. The citation reads: "In recognition of his long years of pioneering research in nutrition. His contributions

to our knowledge of the vitamin content of milk and of the high nutritive value of 'protective foods,' one of which is milk, have served as foundation stones for improving through foods the nutrition and health of the human race."

DR. JOHN FAIRFIELD THOMPSON, executive vice-president of the International Nickel Company, has been awarded for distinguished engineering achievement the Egleston Medal for 1944 of the Alumni Association of the Engineering Schools of Columbia University. The medal was founded in 1939 on the occasion of the seventy-fifth anniversary of the School of Mines of Columbia University. It is given in memory of Professor Thomas Egleston, a pioneer in engineering education and for thirty-seven years a member of the faculty. The medal is awarded annually to an alumnus who distinguishes himself either in the furtherance of his branch of engineering, in the development of processes or techniques or in the application of engineering principles. The presentation was made on April 20 at the seventy-third annual dinner of the Alumni Association. Robert A. W. Carleton, president of the association, presented the award. Dr. Walter S. Landis, vice-president of the American Cyanamid Company, gave an address entitled "Sense and Nonsense in Post-war Planning."

A DINNER in honor of Dr. Arturo Castiglioni, professor of the history of medicine of the School of Medicine of Yale University, president of the New York Society for Medical History, was given in New York City on April 12. The dinner, at which he was presented with an anniversary volume, was in celebration of his seventieth birthday. Addresses of felicitation were made by Dr. John F. Fulton, of Yale University; Dr. Emanuel Libman, of Columbia University; Dr. Mario Voltera, formerly of Padua, Italy, and Dr. Henry E. Sigerist, of the Johns Hopkins University. The toastmaster was Dr. Iago Galdston, of the New York Academy of Medicine. The dinner was attended by two hundred of the friends and associates of Professor Castiglioni.

IN celebration of the seventy-sixth birthday of Dr. H. S. Jennings, professor emeritus of zoology of the Johns Hopkins University, now resident at the University of California at Los Angeles, the library of the university arranged an exhibit of his published works, which was on view from April 10 to 21.

DANIEL W. MEAD, emeritus professor of hydraulic and sanitary engineering of the University of Wisconsin, has been elected an honorary member of the Canadian Institute of Engineers.

DR. ROE E. REMINGTON has resigned as professor of nutrition and director of the Food Research Labo-

ratory of the Medical College of the State of South Carolina, a post which he has held since 1928.

DR. FRED W. ELLIS, associate in pharmacology at the Jefferson Medical College of Philadelphia, has been appointed assistant professor of pharmacology in the School of Medicine of the University of North Carolina.

DR. ERLING W. HANSEN, assistant professor at the Medical School of the University of Minnesota, has been appointed clinical professor of ophthalmology and director of the division of ophthalmology.

DR. EDWARD M. BRIDGE, who has been associated for sixteen years with the Johns Hopkins University, has been appointed to a newly established professorship of pediatrics at the University of Buffalo, and has been made director of the department of research of the Children's Hospital under the joint auspices of the two institutions. The establishment of the research department was made possible by a grant of the trustees of the estate of the late E. M. Statler. The hospital is remodeling a floor of one of its buildings to house the laboratories.

DR. ROY R. KRACKE, professor of pathology and bacteriology and chairman of the department at the School of Medicine of Emory University, has been made dean of the Medical College at Birmingham, Ala. Dr. Stuart Graves, who has been dean of the school during the transition period of its development from a two-year school to a four-year college, will remain as dean of the basic medical sciences.

DR. ROLLA E. DYER, director of the National Institute of Health, which was recently raised to the rank of a bureau, has been made assistant surgeon general.

DR. ARTHUR OSOL, professor of physical chemistry and assistant dean of the Philadelphia College of Pharmacy and Science, chairman of the Philadelphia Section of the American Chemical Society, has been appointed a member of the Technical Advisory Service of the Science Advisory Committee of the Smaller War Plants Corporation.

DR. AVEN NELSON, emeritus professor of botany of the University of Wyoming, of which institution he has been a member since its beginning, is writing his memoirs. Mrs. Aven Nelson has been appointed assistant in the Bebb Herbarium of the University of Oklahoma.

DR. VIRGINIO MANGANIELLO, vice-director of the Astronomical Observatory at La Plata, Argentina, has been appointed director.

ROBERT S. ARCHER, chief metallurgist of the Republic Steel Corporation, of the Chicago District, has

joined the Climax Molybdenum Company as metallurgical assistant to the vice-president.

THE British Council has appointed Dr. P. M. Roxby, professor of geography at the University of Liverpool, to be its principal representative in China. Accompanied by Mrs. Roxby, who is lecturer in history at the university, he will take up his work in China early in 1945.

DR. WALTER J. NICKERSON, head of the department of botany at Wheaton College, Massachusetts, has leave of absence. He is now a lieutenant in the Sanitary Corps assigned to the Physiological Test Section, Proof Department, Eglin Field, Fla.

COLONEL RICHARD P. STRONG, director of tropical medicine at the Army Medical School, Washington, D. C., on March 13 delivered the Julius J. Selman Lecture at Mount Sinai Hospital, Cleveland. His subject was "Tropical Diseases in Relation to the Present War." On the same day he gave a lecture at Western Reserve University entitled "The Pandemic of Plague of the Twentieth Century and Some of the Present Problems Regarding It."

DR. HARLAN T. STETSON, director of the Cosmic Terrestrial Research Laboratory at Needham, Mass., addressed the Geological Section of the New York Academy of Sciences on April 3 on "Modern Evidences for Differential Movement of Certain Points on the Earth's Surface."

DR. HENRY E. SIGERIST, professor of the history of medicine at the Johns Hopkins University, and Dr. C.-E. A. Winslow, professor of public health at the School of Medicine of Yale University, took part on April 14 in a discussion arranged by the Physicians Forum at the New York Academy of Medicine on "Doctor and Patient under a System of National Health Insurance," as proposed in the Wagner-Murray-Dingell Bill.

A SERIES of lectures on popular science and technology is being given from April 7 to May 26 at the Museum of Science and Industry, Chicago. Dr. Milan V. Novak, professor of bacteriology and public health at the College of Medicine of the University of Illinois, gave the first lecture on penicillin. On April 28, Dr. Ralph W. Gerard, professor of physiology at the School of Medicine of the University of Chicago, will speak on "The Biological Aspects of War and Peace," and on May 5, Dr. Andrew C. Ivy, Nathan Smith Davis professor of physiology and head of the department at the Medical School of Northwestern University, will give a lecture entitled "Aviation Calls the Doctor."

A SYMPOSIUM on degenerative diseases, jointly sponsored by the Research Unit of the St. Louis City

Infirmity and the School of Medicine of Washington University, was held in St. Louis on March 24 and 25. The speakers included W. C. Hueper, New York, "The Relation Between Etiology and Morphology in Degenerative and Sclerosing Arterial Diseases"; Irvine H. Page, Indianapolis, "Arteriosclerosis and Lipid Metabolism"; William B. Kountz, St. Louis, "Current Research on Degenerative Diseases at the St. Louis City Infirmary"; Albert Kuntz, St. Louis, "Effects of Lesions of the Autonomic Ganglia and Centers, Associated with Age and Other Disease, on the Vascular System"; Lester R. Dragstedt, Chicago, "The Role of the Pancreas in Arteriosclerosis"; Edward J. Stieglitz, Washington, "Difficulties in Clinical Recognition of Degenerative Diseases"; William J. Kerr, San Francisco, "Correlation of Clinical Knowledge in the Treatment of Degenerative Diseases"; William deB. MacNider, Chapel Hill, N. C., "Age Change and Adjustment"; John A. Saxton, St. Louis, "Nutrition and Growth and their Influence on Longevity in Rats"; and Leo Loeb, St. Louis, "Some Hormone Actions in Relation to the Aging Process." This symposium will be published as Volume XI of Biological Symposia.

THE annual general meeting of the American Philosophical Society, Philadelphia, opened on Thursday, April 20, with a symposium on war-time advances. The meeting will continue through Friday and Saturday.

THE two hundred and sixtieth meeting of the American Physical Society will be held at the Mellon Institute, Pittsburgh, on Friday and Saturday, April 28 and 29. There will be a joint meeting with the Physical Society of Pittsburgh, which has arranged a program on the physics of metals on Friday morning. The new Division of Electron and Ion Optics with I. I. Rabi, *Chairman*; L. Marton, *Vice-chairman*, and J. R. Pierce, *Secretary*, has assembled a group of papers in its field, which will be given on Saturday morning and afternoon. A symposium on cosmic rays will be held on Friday afternoon. Two groups of invited papers, including two on the philosophy of physics, are planned for Saturday. Contributed ten-minute papers, other than those on the program, will be given in four sessions on Friday and Saturday.

IT is planned to hold in June two regional meetings of the American Association of Physics Teachers—one at Cincinnati, Ohio, from June 22 to 25, jointly with the Society for the Promotion of Engineering Education, and one in Rochester, N. Y., on June 23 and 24, concurrently with a meeting of the American Physical Society. A symposium is being arranged dealing with the general application of physical principles in military areas and a program of invited papers on the post-war training of physicists.

THE National Committee for Mental Hygiene announces the establishment of a fund for research in psychosomatic medicine. The purpose is to stimulate and subsidize research in the psychosomatic aspects of the diseases chiefly responsible for disability and death. The fund will be directed by Dr. Edward Weiss. Projects will be considered by the following committee: Dr. Charles M. Aldrich, Dr. Franz Alexander, Dr. Stanley Cobb, Lieutenant Colonel William C. Menninger and Dr. John Romano. It will be administered under the direction of Dr. George S. Stevenson, The National Committee for Mental Hygiene. Communications should be addressed to Dr. Edward Weiss, 269 South 19th Street, Philadelphia 3, Penna.

PRESIDENT ROOSEVELT signed on March 30 a bill authorizing the U. S. Department of Agriculture and the Department of the Interior to make cooperative agreements with private forest owners for the establishment of forest units of sustained-yield by which

the owners would make an agreement to manage their lands in accordance with certain regulations governing the rate, manner and time of cutting.

It is reported in *Nature* that the British Institution of Radio Engineers recommends the formation of a British Radio Research Institute, the functions of which would be the pursuit of basic research of the type that has hitherto suffered restriction owing to its high cost, absence of obvious or immediate practical applications, and the poor prospect of early financial returns. It is proposed that the institute be financed by industry supplemented by a Government grant of at least equal amount. The work would be directed by a board representing governmental authorities, the British Broadcasting Company and the Services, the industry, the British Institution of Radio Engineers, the associated professional institutions and the universities of the Empire. In addition to a permanent scientific staff, the assistance and engagement of extramural workers would be arranged in cooperation with industry and the universities.

DISCUSSION

THE THIRD ANNUAL SCIENCE TALENT SEARCH¹

How do young people develop into great scientists? Can we discover them and then analyze the growth of their scientific careers? A partial answer to such questions is found in the follow-up study now under way concerning participants in the annual Science Talent Search.²

This genetic study of science talent is now in its second year, involving the 3,175 contestants with complete entries for 1942, and the 3,481 contestants with complete entrance materials of 1943. Of the 3,175 follow-up questionnaires sent out in January, 1943, to the 1942 contestants, 2,475 or 78 per cent. were returned, and all the information has since been reduced to punch cards. From these data it is known that of the boys who returned questionnaires, 97 per cent. of the winners, 87 per cent. of the "honorable mentions" and 76 per cent. of the other participants had started college. Among the girls, 89 per cent. of the winners, 92 per cent. of the "honorable mentions" and 70 per cent. of the other participants had begun college. Of 216 in the group of trip winners and "honorable mentions" who returned questionnaires, 100 (77 boys and 23 girls) reported scholarships from various sources, the aggregate sum of which is \$68,988.98.

¹ The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

² The annual Science Talent Search is conducted by Science Clubs of America and Science Service, and is

Annual surveys of the entrants in the first and second contests are planned for at least the next ten years to learn something about the growth of scientists—"how they get that way"—and to give broad information concerning their social, physical and intellectual development. The results should provide valuable data for bettering the educational planning of talented young people who are potential scientists, as well as supply a basis for judging the validity of the selection procedures.

The selection techniques this year—in the Third Annual Science Talent Search—were quite like those previously.³ Of about 15,000 entrants, complete entry materials—science aptitude examination, personal data, scholarship record and scientific essay—were received on about 3,000. This group of high-school seniors, then, were considered to have completed the first hurdle.

The science aptitude examination differed from previous years in that only half of it consisted of a paragraph reading test on materials from various fields of science; the other half was composed of scientific problems, with multiple choice answers. Scores on the paragraph material constituted the second hurdle, scores on the problems the third hurdle. The second hurdle reduced the number of contestants from approximately 3,000 to 1,500. The third hurdle, which was

financed by the Westinghouse Electric & Manufacturing Company.

³ Cf. Harold A. Edgerton and Stuart Henderson Britt, *American Scientist*, 1943, 31, 55-68; *American Scientist*, 1943, 31, 263-265; *Occupations*, 1943, 22, 177-180; "Science and the Future," Washington, D. C., Science Service, 1943, 112-115.

proximately 3,000 students to 812. Of these, 580 were boys and 232 girls, the proportion being in the ratio of the boys and girls with complete entrance materials. The third hurdle eliminated 214 more contestants, leaving 409 boys and 189 girls in the running.

The fourth hurdle was based on the academic record of the individual; the high-school record "composite" score was the sum of relative rank in high-school class and units of high-school science taken, weighted 5:1 respectively. The 450 highest (308 boys and 142 girls) were deemed to have passed this hurdle.

The fifth step was an evaluation of the recommendations made by high-school faculty members.⁴ Five trained raters scored this information in terms of specific actual accomplishments; and on this basis the population was then reduced to 207 boys and 93 girls—containing the 40 trip winners and the 260 students who were given honorable mention.

The essays of these 300 were read separately and scored by three members of the staff of Science Service. Every contestant had written an essay of about 1,000 words on the subject, "My Scientific Project," telling what he or she is doing or plans to do in science in the way of experimentation or other research activity.

At this point, on the basis of all the evidence thus far accumulated—the two sets of scores on the science aptitude examination, high-school record, recommendations and essay—the present writers then made a selection of the 40 trip winners to the Science Talent Institute held in Washington, D. C., 28 boys and 12 girls. *The names and geographical localities represented were completely unknown*, for this information had been blanked out so that identification was by serial number only. Also, no questions concerning either race or religion appeared in any of the forms used.

The final selections, from among the trip winners, of the 2 winners (a boy and a girl) of the \$2,400 scholarships and the 8 winners (6 boys and 2 girls) of the \$400 scholarships, were made with Dr. Harlow Shapley, director of the Harvard College Observatory and chairman of the executive committee of Science Service, acting as the third judge. These decisions were based on the "over-all" previous evidence, plus information obtained from individual, standardized 15-minute interviews specially designed to determine how well the contestant is fitted for a promising career in science. Scores on the Bennett Mechanical Aptitude Test,⁵ which was administered at the Science Talent Institute, were also considered, as well as per-

sonality data obtained in an additional interview by a psychiatrist.

The 40 finalists this year are residents of the following states: Alabama, 2; Arizona, 1; California, 1; District of Columbia, 1; Florida, 1; Georgia, 1; Illinois, 2; Michigan, 1; New Jersey, 3; New York, 14; Ohio, 3; Pennsylvania, 3; Virginia, 1; West Virginia, 1; Wisconsin, 4; and Wyoming, 1.

The scholarships permit the winners to go to any college, university or technical school of their own selection for training in science or engineering; courses that may be pursued are those encompassed in the fields of activity of the National Academy of Sciences and the National Research Council. Eleven of the trip winners in this year's Science Talent Search hope to do research in biology, chemistry, medicine or physics; three want to be electronic engineers; two expect to become theoretical chemists, and one a mathematical physicist. Other choices of probable fields of study range from naval architecture to biochemistry. The careers of these trip winners will be carefully followed.

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CONCERNING "GENOTYPES"

OF recent years there have grown up in both botany and zoology two uses of the word "genotype." That with a longer history is clearly defined in B. Daydon Jackson's "Glossary of Botanic Terms" as "the type of a genus, the species upon which the genus was established." But the usage which is now becoming prevalent is that of "a combination of the genes of an organism." Although the two terms come into little conflict, the former being employed by taxonomists and the latter by geneticists, I have noticed an increasing tendency for taxonomic workers to substitute for this word the phrase "type species." It is well in science to employ such terms as "genotype" with a single unequivocal meaning.

While priority sanctions the taxonomic use of the word, etymology does not. "Genotype" in the genetic sense is based simply and properly upon the Greek *γενοϛ*, meaning "race" or "offspring," but in the taxonomic sense it is based upon the Latin "genus" (as employed in modern science), the stem of which is not "gen" but "gener." Etymologically, the compound of "genus" with "type" should be "generitype" rather than "genotype." We have the right formations in the adjectival "genie" and "generic"; every one recognizes that genie differences are between genes, while generic ones are between genera.

I suggest that the situation be cleared by taxono-

⁴ Cf. Edgerton and Britt, *Occupations*, *op. cit.*

⁵ George K. Bennett and Dinah E. Fry, "Test of Mechanical Comprehension," Psychological Corporation, 1941.

mists replacing the ill-formed word "genotype" by the correctly formed "generitype." This course will not only avoid a needless conflict of terms, but actually will give us a more satisfactory word.

FRANCIS W. PENNELL

TRANSLITERATION OF RUSSIAN NAMES

CONTRIBUTORS to the recent correspondence on the transliteration of Russian names appearing in *SCIENCE*, Vol. 97, p. 243; Vol. 98, pp. 132, 133, seem to be unaware of the fact that the Russian Academy of Sciences had already adopted a system of transliteration as far back as 1906. This Latin transcription of Russian names—which is based on the Czech alphabet—is still being used in the publications of the academy.

In view of this, it would be advisable (as I have already pointed out more than twenty years ago, in *Nature*, Vol. 110, 1922, p. 279) for all countries to conform to the rules already set forth by the Russian Academy, instead of attempting to devise their own systems. This is desirable because, in the event of Russia adopting the Latin alphabet for general use,

the task of formulating the rules will probably be entrusted to this institution, as the highest authority in the country.

The original rules were reproduced in *Nature* of May 14, 1908, p. 42. As they might not be accessible at present and as they do not comply with the new orthography introduced about twenty-five years ago, I have set forth the revised transliteration, which is as follows:

A, a = a	Л, л = l	Ц, ц = c
Б, б = b	М, м = m	Ч, ч = č
В, в = v	Н, н = n	Ш, ш = š
Г, г = g	О, о = o	Щ, щ = šč
Д, д = d	П, п = p	Ъ, ъ = ' (hard)
Е, е = e, je	Р, р = r	Ы, ы = y
Ж, ж = ž	С, с = s	Ь, ь = j (soft)
З, з = z	Т, т = t	Э, э = e
И, и = i	У, у = u	Ю, ю = ju
Й, й = j	Ф, ф = f	Я, я = ja
К, к = k	Х, х = ch	

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SCIENTIFIC BOOKS

HANDBOOK OF MEDICAL ENTOMOLOGY

Insects of Medical Importance. By JOHN SMART. With chapters on Fleas by KARL JORDAN and on Arachnids by R. J. WHITTICK. 269 pp. British Museum, London.

THE application of science in the field by our military forces has presented many difficulties, especially in the realm of biology as related to medicine and in matters pertaining to public health. Suddenly a great need arose for a large personnel acquainted with the practical phases of these subjects. Extensive training has been successfully undertaken, but there has existed a real lack of useful handbooks to aid those who could not enjoy the academic atmosphere of libraries and laboratories. In no field, perhaps, has it been more difficult to meet the demand for competent workers than in medical entomology. In many countries the danger from insect-borne diseases such as malaria, bubonic plague and typhus is ever present, while the prevalence of others like typhoid fever and cholera is greatly augmented through the activities of particular insects.

The present book is an attempt to present in brief form material that will enable workers who lack extensive training in taxonomic entomology to recognize and determine with some degree of certainty those insects that menace the public health in the several war zones of the Old World.

By reason of the paramount importance of malarial fevers a major part of the text and illustrations is devoted to a consideration of the species of anopheline mosquitoes, with keys for their identification both as larvae and adults. This section includes over 70 pages with many fine drawings of anatomical details. The numerous species are grouped geographically as Palaearctic, Ethiopian, Oriental and Australian and extensive notes are presented to correlate these larger areas with specific places or borderland countries. Such an arrangement should be especially helpful in dealing with this large complex, in which only a small proportion of the species are important vectors of malaria, despite their close structural similarity. Ecological notes on breeding places are included. There is a general review of the other blood-sucking Diptera with a table for the recognition of the several important families and more complete accounts of some groups. Thus, the gad-flies (Tabanidae) and the African tsetse flies are treated more extensively, especially the latter. A general account of Dipterous larvae that invade the body is given in a section on myiasis, together with enumerations of blow-flies and maggots that may occur in foods. To all sections frequent bibliographic references are appended in the form of footnotes.

A section on fleas, written by Dr. Karl Jordan, will prove valuable, although it is far less complete than the part on mosquitoes.

In any such compendium much must necessarily be omitted and the material that is included requires careful selection to avoid serious gaps. Dr. Smart has quite consistently passed over all reference to groups that are of zoological interest only, which means, of course, that the greater part of the book deals with the Diptera. Aside from insects, there are several short accounts of some other arthropods, mainly mites and ticks.

Although this book was prepared and printed in England, under the most trying conditions and undoubtedly in considerable haste, the material is singularly well selected, carefully prepared and beautifully printed on first-class paper. It may be heartily recommended, especially to entomologists overseas as a brief, practical aid in the identification of disease-bearing insects. The one really serious defect is the very incomplete and wholly inadequate index.

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CHEMISTRY OF ORGANIC MEDICINAL PRODUCTS

The Chemistry of Organic Medicinal Products. By GLENN L. JENKINS and WALTER H. HARTUNG. Second edition. vi+675 pp. John Wiley and Sons, Inc., New York; Chapman and Hall, Ltd., London. October, 1943. $5\frac{1}{4} \times 8\frac{1}{2}$ in. \$6.50. Bound in dark-red cloth.

THAT a second edition of this book should appear only two years after the first one (reviewed in *SCIENCE*, n.s., 96, 516; December 4, 1942), indicates that there is a considerable demand for a compact yet comprehensive treatment of this exceedingly interesting and rapidly expanding field, and that this particular work has met with favor.

On the material side, the new edition differs from the old in being printed instead of planographed, and bound in cloth in place of stiff paper. To provide space for the supplementary information given, including a wholly new chapter on "Some Physicochemical Properties of Medicinal Products," over 200 pages have been added. The former text has been thoroughly revised and some chapters completely rewritten.

In other respects, the book remains much the same, and should prove helpful to both chemists and medical men who wish to refresh their memories on the older drugs and learn something about the newer ones, for it includes methods of preparation, properties, uses and modes of administration.

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ORGANIC CHEMISTRY

Laboratory Practice of Organic Chemistry. By G. ROSS ROBERTSON. x+369 pp. Illustrated. Macmillan Company. 1943. \$2.50.

THE author has presented an excellent laboratory manual for the beginning organic chemistry student. Part I, containing chapters 1-16, introduces the most thorough and clearly organized theoretical development the reviewer has seen in any organic laboratory manual. The thorough drilling in the theory and techniques of the elementary laboratory practice should help to eliminate the "cook-book" chemist in the majority of beginning organic students.

Part II introduces detailed instructions for fifty-nine typical and well-selected experiments in organic chemistry. The experiments are designed to cover both the aliphatic and aromatic series, and experiments may be chosen from both series to be applied to a one-semester course primarily for premedical students.

The reviewer feels this revised edition is one of the best beginning organic laboratory manuals available.

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MATHEMATICAL PHYSICS

Methoden der Mathematischen Physik. By R. COURANT and D. HILBERT. 2 volumes. Interscience Press. By permission of the Alien Property Custodian. \$8.00 each; \$14.00 the pair.

THE two volumes by Courant and Hilbert are already widely known among mathematicians and physicists for their clarity, rigor and breadth of view. They constitute an outstanding source of material on expansion methods and partial differential equations. American mathematical physics will be benefited both during the war and after by having them available at a greatly reduced price.

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REPORTS

THE AMERICAN ACADEMY OF TROPICAL MEDICINE¹

IN view of the importance of tropical medicine in our present activities in tropical war theaters and in view of the world-wide significance of the problems involved now and in the immediate future, it has seemed desirable that the program and recommendations of the American Academy of Tropical Medicine, which have been prepared on request and have been unanimously endorsed by the academy and approved by the American Foundation for Tropical Medicine, be placed on record for the scientific public. Since no scientific organ has as wide-reading public as does SCIENCE, it is appropriate that this report should appear in full in this journal.—ERNEST CARROLL FAUST, *Secretary, American Academy of Tropical Medicine*.

I

INTRODUCTION

At the tenth annual business session of the American Academy of Tropical Medicine, held in Cincinnati on November 17, 1943, the following resolutions were adopted:

1. That the president be authorized, with the advice and consent of the council, to appoint a committee to clarify the relations of the academy to the foundation's program, and to make specific recommendations in order to activate the provisions of the constitution of the academy with respect to education and research in tropical medicine in the United States and in the international field.

2. That the council be authorized to take action on behalf of the academy on the report of this committee and to implement such of the recommendations as may seem advisable.

3. That the council be instructed to recommend to the foundation support of the program to be developed.

Following the adoption of the resolution by unanimous vote, President L. W. Hackett announced the appointment of the following persons as members of the committee: Dr. N. Paul Hudson; Dr. Alfred C. Reed; Dr. Wilbur A. Sawyer, *Chairman*; Brigadier General James S. Simmons; Dr. R. E. Dyer; Dr. George C. Shattuck; Dr. E. C. Faust, *Secretary*.

At noon on the following day a brief meeting of the committee was held between sessions of the American Society of Tropical Medicine. By invitation Dr. T. T. Mackie, president of the American Foundation for Tropical Medicine, met with the committee. It was agreed that the several members would send in suggestions and that the chairman thereafter would prepare a tentative draft of a report and submit it for amendment and correction and finally for adoption by mail vote. Dr. Mackie emphasized the need of the foundation for the academy's recommendations as to

¹ Report of the committee on the relations of the academy to the program of the American Foundation for Tropical Medicine and on recommendations to the foundation for a program of education and research.

program and urged that they be made available by the middle of January.

A few days later, on November 20, 1943, Dr. E. C. Faust, secretary of the academy and member of the committee, wrote to the members asking them to send their views on the questions before the committee to the chairman without delay. All members had been heard from by December 20, 1943.

The questions before the committee are two: (1) What is, or should be, the relation of the academy to the foundation's program? (2) What program of education and research will the committee submit to the council of the academy for recommendation to the foundation?

II

THE RELATION OF THE ACADEMY TO THE PROGRAM OF THE FOUNDATION

The constitution of the American Academy of Tropical Medicine contains the following statement of purposes as formulated when the academy was organized in 1934:

Purpose: The purposes and aims of The American Academy of Tropical Medicine, Incorporated, shall be:

1. To further the extension of knowledge for the prevention of human and animal diseases of warm climates by stimulating interest, inquiry and research into their distribution, causes, nature, treatment and methods of control.

2. Through designated committees in the several fields of knowledge contributing to tropical medicine, to provide a current survey of work in progress in tropical medicine and sanitary and hygienic work related thereto.

3. To coordinate American work in tropical medicine to the end that unnecessary duplication and overlapping shall be avoided as far as possible, and that valid lines of study shall not be neglected.

4. To function as a central source of information for the advantage of investigators in this field of knowledge.

5. To cooperate with other agencies interested in maintaining and obtaining support for tropical medicine, both in a financial way and to the end that the medical professions, the general body of scientific workers and the general public may be better informed regarding the values and needs of tropical medicine in national and international programs.

6. To receive funds and administer them through grants-in-aid and in support of definite projects related to the purposes and aims of the academy as set forth in paragraph 1.

Although paragraph 6 of the "Purposes" suggested that the academy would receive funds and administer them in support of projects, etc., it appears that from the beginning it was recognized that the academy as a scientific body would not interest itself in soliciting funds from the public for tropical medicine, and there-

fore the formation of a foundation was suggested.² The suggested foundation was to be made up essentially of an executive group as contrasted to the scientific group in the academy. Dr. McKinley, in a letter which he quotes in the above-mentioned brochure, states that "Once the directorate of the Foundation of Tropical Medicine is created this new organization will proceed to raise funds to support work in this field of medicine." At that time it was plainly the purpose to have the academy and the foundation in close relationship, one preparing the program for developing the field of tropical medicine and the other, composed largely of executives of interested institutions, soliciting, holding and distributing the funds. Nevertheless, there was no mention of the Academy of Tropical Medicine in the certificate of incorporation or the by-laws of the foundation and the latter provided for a medical committee to make recommendations as to the medical value of projects. The general purposes of the foundation were similar to those of the academy, but more emphasis was placed on financial powers. The first directors were predominantly university presidents and other laymen.

With the passage of time the composition of the membership of the foundation changed and more medical men were included. The relationship to the academy, which had never been formally recognized, became less intimate and certainly more obscure. The following extract from a letter of the secretary of the foundation, Alfred R. Crawford, dated December 23, sums up the situation:

It seems clear, especially from the brochure, that it was originally intended that the foundation should be the fiscal and fund-raising body of the academy. The fact that Dr. McKinley was named the first executive director of the foundation when it was originally organized testifies to this intention. It appears that there would be interlocking boards of directors and a close identity of operations. These conditions may have obtained in the original foundation. As you know, the death of Dr. McKinley cut short the realization of the ambitious plans he had and since the reorganization of the foundation there has been no formal and little informal contact between the foundation and the academy and society.

The move to have the society and the academy name representatives on the board of directors of the foundation was taken on the initiative of the foundation during the past year. This was stressed at the meeting of the council of the academy in Cincinnati. The informal affiliation would, it was felt, be a means of identifying the foundation more closely with the work of the two related organizations and make it more truly the instrument which its originators had in mind.

I would judge the feeling of the group of council mem-

² Brochure on "The Development of Tropical Medicine in the United States," by Dr. E. B. McKinley, 1930, pp. 24-26.

bers who discussed this matter in Cincinnati to be somewhat along these lines:

1. That the foundation should maintain an independent status though be guided by the academy and society.

2. That this be accomplished by representation of the society and academy on the foundation's board of directors. Dr. Faust was named the society's representative and will be elected at the meeting in February. Dr. Shattuck, who is already a director, has been, we understand, recommended as the academy's appointee.

3. That the foundation shape its program around recommendations formulated by a joint committee of the academy and society which would define the general type of teaching, research or allied work which the foundation should undertake to finance.

4. That the liaison be further strengthened by active assistance in such matters as selections for fellowships and through constant reference and interchange of information.

Following Dr. McKinley's death, Dr. T. T. Mackie was designated the official representative of the academy in the Foundation for Tropical Medicine. After Dr. Mackie was elected president of the foundation, Dr. G. C. Shattuck was nominated as representative of the academy on the foundation's board of directors (letter of Mr. A. R. Crawford of December 30, 1943).

The division of function between the academy and the foundation at the present time seems clear. The foundation's board of directors, on which the academy and the Society of Tropical Medicine will be represented, has full responsibility for negotiating and approving projects and appropriating available funds for their support. The academy, through its committees and council, is expected to express its opinions as to desirable developments in the field of tropical medicine and give the foundation the benefit of its judgment, when requested, as to the wisdom of going into specific projects. The foundation, unlike the academy, could maintain and finance the staff necessary to negotiate and investigate proposed projects and to determine the amounts and conditions of appropriations. It would seem unwise for the academy to operate even an information bureau, since the most reliable advice in response to miscellaneous questions could be made available by reference to the institutions and individuals most qualified to reply. In brief, the academy can accelerate progress in the field of tropical medicine by making authoritative pronouncements as to the needs in that field, by recommending general programs to the foundation when requested, by answering inquiries as to the advisability of specific projects of the foundation in their general features, and by giving moral support to the movement to improve teaching and research in tropical medicine, both curative and preventive.

In the present instance it is evident that the advice

of the academy with regard to program is invited by the foundation as its president, Dr. T. T. Mackie, has stressed to the committee the desire for early submission of suggestions for consideration by the foundation.

(1) *It is recommended* that the academy, while recognizing the independent status of the American Foundation for Tropical Medicine, respond to any invitation from the foundation for suggestions regarding its program by the submission of reports of appropriate committees through the council; and that, in case the invitation should be directed to the American Society of Tropical Medicine as well as the academy, the suggestions be prepared by a joint committee and submitted through the councils of the society and academy.

III

SUGGESTIONS FOR THE PROGRAM OF THE FOUNDATION

The mandate to the committee, as expressed in the resolution authorizing its appointment, was in part "to make specific recommendations in order to activate the provisions of the constitution of the academy with respect to education and research in tropical medicine in the United States and in the international field." The academy's principal opportunity to advance education and research at this time would seem to be through suggestions to the foundation with regard to its program.

The committee bases its recommendations on its firm belief that tropical medicine will increase in importance to the United States after the war. The military necessities have revealed the inadequacy of the previous training of medical men in tropical medicine in this country. Emergency courses and field experience for military medical men and teachers in medical schools have been sponsored by the Army Medical School and private agencies but are not expected to continue after the urgent military need has passed. There is now great wartime activity and expenditure of funds in foreign countries in health and other fields by our government and institutions. The effect has been to bind these countries more closely to the United States and to lead the other American countries to look in this direction for postgraduate instruction in medicine and tropical diseases, as they once looked to Europe.

The committee is of the opinion that the main emphasis of the foundation in its program should be on the stimulation, expansion and improvement of facilities for graduate and undergraduate instruction in tropical medicine in the United States.

In the graduate field there should be strong schools or departments of tropical medicine for postgraduate instruction of medical men who are intending to teach tropical medicine or to practice it in this country or

abroad. Such schools or departments should be in university centers containing schools of medicine and public health with teaching hospitals and practice fields and should have close relationship to departments of engineering and nursing. Ties to schools in the nearer tropics would be an additional advantage. The schools or departments of tropical medicine would be closely linked to the medical schools in the teaching of clinical tropical medicine and to the schools of public health in the even more important subject of disease prevention. The organized teaching in tropical medicine would need to go far beyond existing instruction in medical schools and in most schools of public health with respect to certain biological branches of learning related to the epidemiology of tropical diseases, such as protozoology, entomology and helminthology. Attention should also be given to the scientific consideration of the effects of geography, climate, racial composition, nutrition and social conditions on the epidemiology of disease in the tropics. Most certainly the prevention of disease, the suppression of disease-carrying insects and the prevention of the transportation of insect vectors between countries should be given careful consideration. Rapid transit is one of the factors which has brought this country closer to the tropics and made it more vulnerable to tropical diseases. The adequate teaching of epidemiology and biostatistics is fundamental.

(2) *It is recommended* that the foundation assist or bring into being a strong school or department of tropical diseases in each of the following regions of this country—the South, the Atlantic Seaboard and the Pacific Coast.

Comment: For the South the present support to postgraduate instruction at the department of tropical medicine of Tulane University should be continued and increased sufficiently to permit the sending of students to tropical Mexico for field experience and to justify the granting of a diploma in tropical medicine and public health. For the Atlantic Seaboard and the Pacific Coast the committee is not ready to make a statement of preferred institutions or cities, but the selection should depend to a considerable extent on the actualities or early prospects of adequate provisions for teaching medicine and public health in the centers under consideration. Consideration should be given to the strengthening of the School of Tropical Medicine in Puerto Rico now affiliated with Columbia University.

The schools or departments of tropical medicine would be expected to draw students from tropical America as well as from the United States. Taking special interest in foreign students from the tropics they would see that these students obtained the required medical and public health training under favor-

able conditions. Such students may need special language instruction and supervision during the early months of their studies, and racial factors may determine in part which school and community would be most favorable.

The subsidies to these schools should contain sums for research by faculty and advanced students, both at their institutions and in the tropics. The cost of travel makes foreign investigations and research expensive, but there is no question that productive field research adds to the prestige and value of the schools. If faculty members can cooperate with the health authorities of tropical countries in important investigations, without causing additional expenses to the foreign governments, they are usually welcome.

(3) *It is recommended* that the foundation make available grants-in-aid to competent investigators in important problems of tropical medicine, the research to be carried on within or without the schools and departments otherwise assisted, and inside or outside the United States.

Comment: The offering of grants-in-aid is an established technic of philanthropic foundations. In this case it would imply that the Foundation for Tropical Medicine, through its own staff and its advisers, would be in a position to make competent decisions, in each field in which grants are given. The object of the grants-in-aid would be to produce needed knowledge through research while that of fellowships would be training for future service.

(4) *It is recommended* that the foundation establish a moderate but flexible number of fellowships and travel grants for graduate students from the United States or foreign countries and for teachers or prospective teachers of tropical medicine in the United States or abroad, and that the study be either in the United States or abroad, but that the fellowships be granted only under conditions as to future service by the individual, and that prospective students be interviewed by or for the officers before the fellowships are granted.

Comment: The study and observations under such fellowships or travel grants could be in the United States or in a foreign country, and should be wherever the opportunities are best. In some cases travel grants without stipend would be the most appropriate form of assistance, as the employing institution may be able to continue salary, but not to provide travel.

(5) *It is recommended* that undergraduate instruction in tropical medicine in medical schools be assisted by the foundation through fellowships to the teaching staff and through making available teaching materials, and in some special cases by grants-in-aid; and that opportunity be given key technicians of diagnostic laboratories of public health departments or hospitals

to receive instruction in the diagnosis of tropical diseases under a special type of travel grant or fellowship.

It is recommended that assistance be given by the foundation to the *American Journal of Tropical Medicine* and the *American Journal of Parasitology*. The committee understands that the former is now on a self-supporting basis as a bimonthly journal, but it believes it would facilitate the spread of knowledge regarding tropical medicine here and abroad if the *American Journal of Tropical Medicine* could be issued monthly and could contain new departments for editorials, reviews, communications, etc., after the restrictions on paper have been removed. These journals are regarded as educational mediums and are therefore considered here.

(6) *It is recommended* that the exchange of professors between foreign teaching institutions of tropical medicine and those in the United States be arranged and subsidized at least to the extent of furnishing travel costs when not otherwise provided.

Comment: It should be kept in mind that some of the best places for study, experience and research are outside this hemisphere, e.g., in Singapore or Calcutta, and should be considered as possible places of study along with the American tropical countries. To help foreign tropical countries to educate their own nationals in tropical medicine, while sending the most promising graduates abroad for supplementing training and experience, should be the ultimate educational objective, but in the meanwhile a considerable number of graduate students should be brought here from the tropics for more basic postgraduate training. Any idea that many United States physicians could find opportunities in practice in tropical medicine in foreign countries, is probably mistaken and should be corrected. Training in tropical medicine will be mostly for service in public health and governmental medical care. Nevertheless, our own government will doubtless share in an international responsibility to maintain and improve health in certain tropical and subtropical areas after the war and will need medical personnel trained in tropical medicine and its many specialties ranging from parasitology to nutrition. In any event a greater knowledge of tropical medicine by the medical profession of the United States is an urgent need.

This report has been reviewed, corrected and adopted by the committee, and is respectfully submitted to the council of the academy.

WILBUR A. SAWYER, *Chairman*

ERNEST CARROLL FAUST, *Secretary*

Approved by the council of the academy and submitted to the American Foundation for Tropical Medicine, February 4, 1944.

SPECIAL ARTICLES

AZIDE INHIBITION OF ANAEROBIC ASSIMILATION OF GLUCOSE BY YEAST AND ITS APPLICATION TO THE DETERMINATION OF FERMENTABLE SUGAR

In the determination of fermentable sugar by yeast fermentation methods, the amount of carbon dioxide produced is usually 10 to 35 per cent. lower than that expected from the familiar equation for alcoholic fermentation. The low recoveries appear to be due to the assimilation of a portion of the sugar to form intracellular carbohydrate, since anaerobic assimilation of appreciable amounts of glucose by yeast has been observed even in very short term experiments.^{1, 2}

Sodium azide and other respiratory poisons have been observed to inhibit the anaerobic uptake of ammonia³ and the aerobic assimilation of several oxidizable substrates^{4, 5, 6} by yeast. This suggested that the anaerobic assimilation of fermentable sugars could also be stopped by using these inhibitors, thus allowing conversion of all the fermentable sugar to carbon dioxide and alcohol. This possibility was tested by measuring manometrically the total carbon dioxide produced from the anaerobic fermentation of known

duction corresponded to 67 per cent. of the added glucose in the absence of inhibitor, and 100 per cent. in the presence of 10^{-3} M sodium azide. The rate of fermentation was not altered by this concentration of azide. Table 1 also shows a similar increase in the carbon dioxide produced from the fermentable sugar in rat serum and in tungstic acid filtrates of this serum by yeast when azide was present. Known amounts of glucose were completely fermented in rat serum in the presence but not in the absence of azide.

If young (24-hour) pure cultures of yeast (*Saccharomyces cerevisiae* isolated from commercial bakers' yeast) were used immediately upon removal from slants and washing by centrifugation, glucose recoveries were only 5 to 10 per cent. lower than theoretical. If however, the yeast was aerated 2 to 10 hours after washing, the recoveries were increasingly low, reaching a minimum of about 33 per cent. lower than theoretical. This value of 67 per cent. recovery was obtained repeatedly in aerated yeast, and suggests that under optimum conditions for assimilation, one third of the glucose is synthesized into cell material (presumably glycogen), the rest being fermented. Similar results have been obtained in the aerobic metabolism of glucose and other substrates.^{4, 5, 6, 7}

The fact that anaerobic assimilation of glucose and ammonia can be completely inhibited by cellular poisons usually considered to be inhibitors of heavy metal enzymes might suggest that iron-containing enzymes are involved in the assimilation of both carbon and nitrogen by yeast. However, a selective inhibition of aerobic assimilation has been described for a number of other toxic substances including iodoacetate and dinitrophenol, and the azide inhibition of anaerobic assimilation should not yet be considered good evidence that heavy metal catalysts are involved in the assimilation reactions.

These results indicate that an improvement in the manometric or titrimetric determination of fermentable carbohydrate may be achieved by carrying out the yeast fermentation in the presence of sodium azide. We have found it satisfactory to place the sample containing 0.2 to 2 mg of glucose equivalent buffered at pH 4.5 with 0.05 M succinate and 10^{-3} M in sodium azide in the main compartment of Warburg vessels. About 25 mg of washed bakers' yeast is added from the side arms after temperature equilibration and removal of oxygen with nitrogen. The production of carbon dioxide is followed until it virtually ceases (in 10 to 40 minutes), and the amount of fermentable car-

⁷ C. B. van Niel and A. L. Cohen, *Jour. Cell. and Comp. Physiol.*, 20: 95, 1942.

TABLE 1

EFFECT OF 10^{-3} M SODIUM AZIDE ON RECOVERY OF GLUCOSE (TEMPERATURE 30° C., PH 4.5, 0.05 M SUCCINATE, 25 MG WASHED BAKERS' YEAST IN NITROGEN GAS)

Azide	Glucose	Rat serum	Tungstic acid filtrate of rat serum (1:10)	Total CO_2 produced	Glucose equivalent to CO_2	Per cent. recovery
m	mg	cc	cc	mm ³	mg	
0	0	0	0	7.0	0.028	67
0	1.0	0	0	166	0.67	67
10^{-3}	1.0	0	0	251	1.01	101
0	2.0	0	0	336	1.35	67
10^{-3}	2.0	0	0	505	2.04	102
0	0	.3	0	87	0.35	..
10^{-3}	0	.3	0	128	0.52	..
10^{-3}	1.0	.3	0	382	1.54	102
0	0	0	1.5	44	0.18	..
10^{-3}	0	0	1.5	64.0	0.26	..
10^{-3}	1.0	0	1.5	320	1.29	103

amounts of glucose by washed bakers' yeast in the presence or absence of 10^{-3} M sodium azide. Table 1 shows typical results. The total carbon dioxide pro-

¹ C. B. van Niel and E. H. Anderson, *Jour. Cell. and Comp. Physiol.*, 17: 49, 1941.

² R. J. Winzler and J. P. Baumberger, *Jour. Cell. and Comp. Physiol.*, 12: 183, 1938.

³ R. J. Winzler, Dean Burk and V. du Vigneaud (in press).

⁴ C. E. Clifton, *Enzymologia*, 4: 246, 1937.

⁵ R. J. Winzler, *Jour. Cell. and Comp. Physiol.*, 15: 343-354, 1940.

⁶ M. J. Pickett and C. E. Clifton, *Jour. Cell. and Comp. Physiol.*, 22: 147, 1943.

bohydrate is then calculated as glucose from the following relation:

$$\text{mg. of glucose in sample} = \frac{\text{mm}^3 \text{ CO}_2 \text{ produced}}{248 \text{ mm}^3}$$

No determination of a correction factor from standard glucose solutions is necessary.

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CONVERSION OF GLOBULAR TO ORIENTED FIBROUS PROTEINS

It was reported recently¹ that several globular proteins can be changed into a fibrous form by heating them in the presence of water and subjecting them to high shear stress. As evidenced by x-ray diffraction, the converted protein molecules have substantially the same spatial arrangement as the molecules of the natural fibrous protein, β -keratin, as it occurs in feathers and stretched wool and hair. To the list of globular proteins that can thus be made fibrous in the molecular sense may now be added gliadin, the mixed proteins of blood serum² and the globulins of tobacco and pumpkin seed.²

Conversion from the globular to the fibrous form has also been effected by soaking protein filaments in aqueous solutions of various reagents, followed by stretching, both treatments being carried out at room temperature.^{3,4} Ovalbumin, lactoglobulin, casein and pumpkin seed globulin have been converted from the globular to the oriented fibrous form in this way. Ovalbumin has been particularly easy to unfold and orient. β -keratin diffraction patterns have been given by ovalbumin filaments stretched at room temperature after being treated with such aqueous solutions as the following: 75 per cent. methanol, 75 per cent. ethanol, 75 per cent. isopropanol, 50 per cent. t-butanol, saturated benzyl alcohol, 5 per cent. phenol, 75 per cent. formamide, 50 per cent. urethane, 50 per cent. pyridine, saturated aniline, 75 per cent. acetaldehyde, 90 per cent. acetone, saturated methyl ethyl ketone, 50 per cent. ethylene glycol monoethyl ether, 75 per cent. dioxane, 10 per cent. chloral hydrate, 10 per cent. silver nitrate, saturated cerous nitrate, 50 per cent. cupric nitrate, 10 per cent. trichloroacetic acid, 25 per cent. sulfuric acid, 20 per cent. hydrochloric acid, 17 per cent. nitric acid, 10 per cent. toluene sulfonic acid and 5 per cent. sodium hy-

droxide. Ovalbumin filaments soaked in acetic anhydride, glacial acetic acid, 98–100 per cent. formic acid, 65 per cent. lithium bromide, 50 per cent. ammonium thiocyanate, or saturated aqueous solutions of either urea or guanidine hydrochloride, and then in water were stretched to give the β -keratin structure.

It should be mentioned that the "egg-white" pattern of Astbury, Dickinson and Bailey,³ characterized by the 9.8 Å reflection on the equator and the 4.7 Å reflection on the meridian, has been obtained also from chemically treated ovalbumin.¹

The concentration of the reagent is not critical, and the time of soaking required to render the filaments stretchable ranges from a few minutes to several hours. For example, filaments soaked in saturated ammonium thiocyanate for two minutes and then in water for three minutes were stretched to a draw ratio (ratio of final to initial length) of 4.9 and gave the β -keratin pattern. Soaking in saturated aniline did not produce good stretching characteristics until after about five hours. Roughly, a draw ratio of five is required to give good orientation. If internal friction is small, the high shear required for orientation is not developed on stretching, and despite a large draw ratio the specimen gives only an amorphous diffraction pattern. Conversely, if cohesion and internal friction are large, a draw ratio of only two or three will give good fiber patterns. Ordinarily, filaments are most easily stretched while moist, but certain ovalbumin preparations, particularly those treated with phenol solution, may be stretched readily when air-dry. The phenol-treated ovalbumin filaments were also remarkable in that they exhibited the typical characteristics⁵ of cold drawing, that is, on application of tensile stress they "necked down" and with continued stretching the necked-down, oriented section grew at the expense of the larger, unoriented sections.

Chemical treatment increases the degree of ordering of the peptide chains. Strong diffraction rings at approximately 4.7 and 9.8 Å sharpen, and fainter rings are resolved from diffuse halos.⁶ As many as five diffraction rings have been obtained from ovalbumin treated with aqueous methanol, formamide or urethane. The rings from the formamide-treated ovalbumin occurred at 10.7, 4.7, 3.7, 2.2 and 2.0 Å. As a rule, preparations showing the largest number of diffraction rings and the sharpest rings were most easily oriented and gave fiber patterns containing the greatest

¹ F. R. Senti, C. R. Eddy and G. C. Nutting, *Jour. Am. Chem. Soc.*, 65: 2473, 1943.

² We should like to thank Sharp and Dohme, Inc., for the serum proteins, and H. B. Vickery, of the Connecticut Agricultural Experiment Station, for the pumpkin seed globulin.

³ W. T. Astbury, S. Dickinson and K. Bailey, *Biochem. Jour.*, 29: 2351, 1935.

⁴ K. J. Palmer and J. A. Galvin, *Jour. Am. Chem. Soc.*, 65: 2187, 1943.

⁵ W. H. Carothers and J. W. Hill, *Jour. Am. Chem. Soc.*, 54: 1579, 1932.

⁶ G. L. Clark and J. H. Shenk, *Radiology*, 28: 58, 144, 1937, observed sharpening of the 4.7 and 9.8 Å diffraction rings of ovalbumin and hemoglobin precipitated from dilute solution by trichloroacetic acid, ethanol, acetone or formalin. M. Spiegel-Adolph and G. C. Henny, *Jour. Phys. Chem.*, 46: 58, 1942, observed sharpening of the pattern of pseudoglobulin denatured by ethanol.

detail. The nine forms found in the fiber pattern of β -keratin and heated ovalbumin¹ have been found also in chemically treated ovalbumin. The chemicals used were by no means equally effective in converting the globular protein to the fibrous form. However, the degree of crystallinity and orientation produced by treatment with aqueous formamide, urethane or aliphatic alcohols was at least equal to that obtained after heat treatment. Judging from the sharpness and length of the diffraction arcs, the best of the converted protein preparations were equal to the natural fiber, raw silk, in both crystallinity and orientation.

Filaments of the more soluble proteins were pre-

pared by mixing the powdered material with approximately half its weight of water and extruding the mixture through a die in an arbor press. One per cent. of sodium chloride was added to the mixture of pumpkin seed globulin and water to make it readily extrudable. Casein filaments were extruded from a briefly heated casein-water mixture. This heating produced no detectable change in the x-ray diffraction pattern.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CLOSED CIRCUIT APPARATUS FOR THE MEASUREMENT OF RESPIRATORY METABOLISM

SEVERAL devices for calorimetry of small animals have been described.^{1, 2, 3, 4} Metabolic studies frequently require the determination of the exchange of respiratory gases for large numbers of animals. Because of certain disadvantages in some of these meth-

length. A screw cap is fitted to one end and a smaller brass tube 3 inches (7.6 cm) long and $3\frac{1}{4}$ inches (8.3 cm) in diameter is riveted to the other end and closed by a screw cap. The smaller tube contains a 6-volt electric motor and fan assembly from an automotive windshield defrosting unit. This centrifugal fan circulates the gases through a 1-inch (2.5 cm) glass tube which is filled with soda lime and attached by rubber

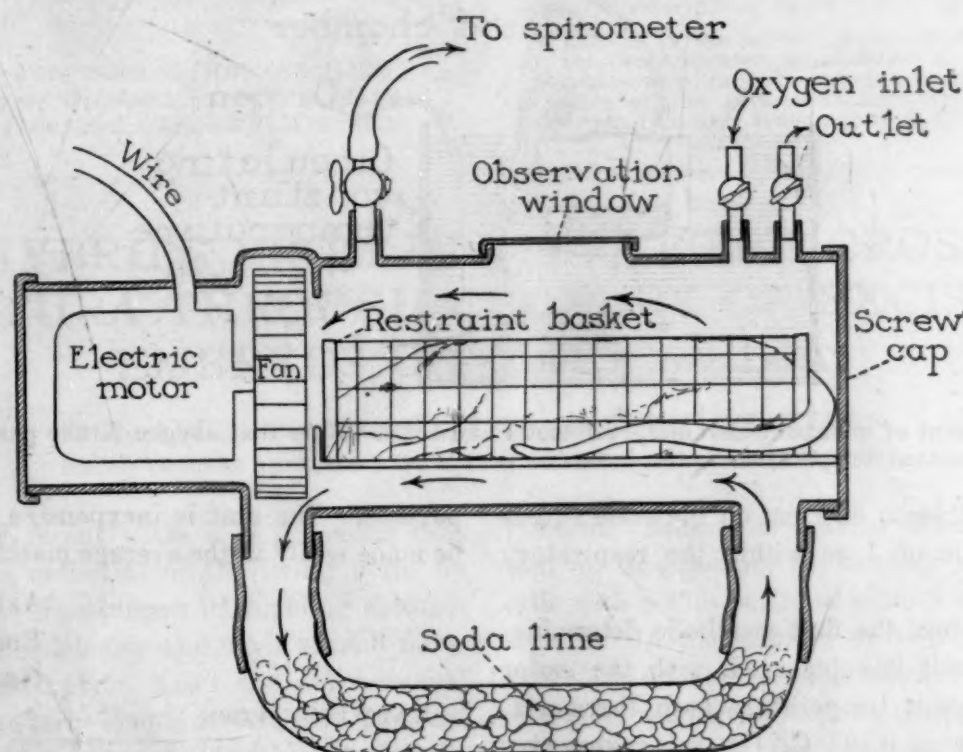


FIG. 1. Cross section of metabolic chamber showing rat in place in restraint basket.

ods we have devised an apparatus shown in Figs. 1 and 2.

The chamber is constructed of heavy brass tubing, 4 inches (10 cm) in diameter and 9 inches (23 cm) in

¹ F. G. Benedict and Grace MacLeod, *Jour. Nutrition*, 1: 343-366, 1929.

² M. L. Tainter and D. A. Ryland, *Proc. Soc. Exper. Biol. and Med.*, 32: 361-363, 1934.

³ E. L. Schwabe and F. R. Griffith, Jr., *Jour. Nutrition*, 15: 187-198, 1938.

⁴ W. H. Newton, *Jour. Physiol.*, 89: 421-428, 1937.

connections to the bottom of the main chamber.

Three outlets equipped with stopcocks lead from the upper part of the chamber; one is for the inflow of oxygen, one is a simple outlet or vent and the third one connects the respiratory chamber with a small, brass, Krogh spirometer measuring $5\frac{1}{2}$ by 3 by $2\frac{1}{2}$

⁷ One of four Regional Research Laboratories operated by the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

inches (14 by 7.6 by 5.7 cm). Kerosene was found to be a satisfactory fluid for use in the spirometer. A concave mirror is attached to the axis of the spirometer float, so that any change of volume within the respiratory chamber causes a rotation of the mirror. The image from a single filament bulb is focused by the concave mirror on an arc equipped with a centimeter scale, the radius of which is such that an ex-

during five minutes indicates the volume of oxygen consumed in that period. Three to five consecutive readings are obtained. Water vapor pressure is maintained constant by the presence of a moist sponge in the chamber.

The performance of this apparatus is entirely satisfactory in our hands. Any limitations of the method are in the experimental animal and not in the ap-

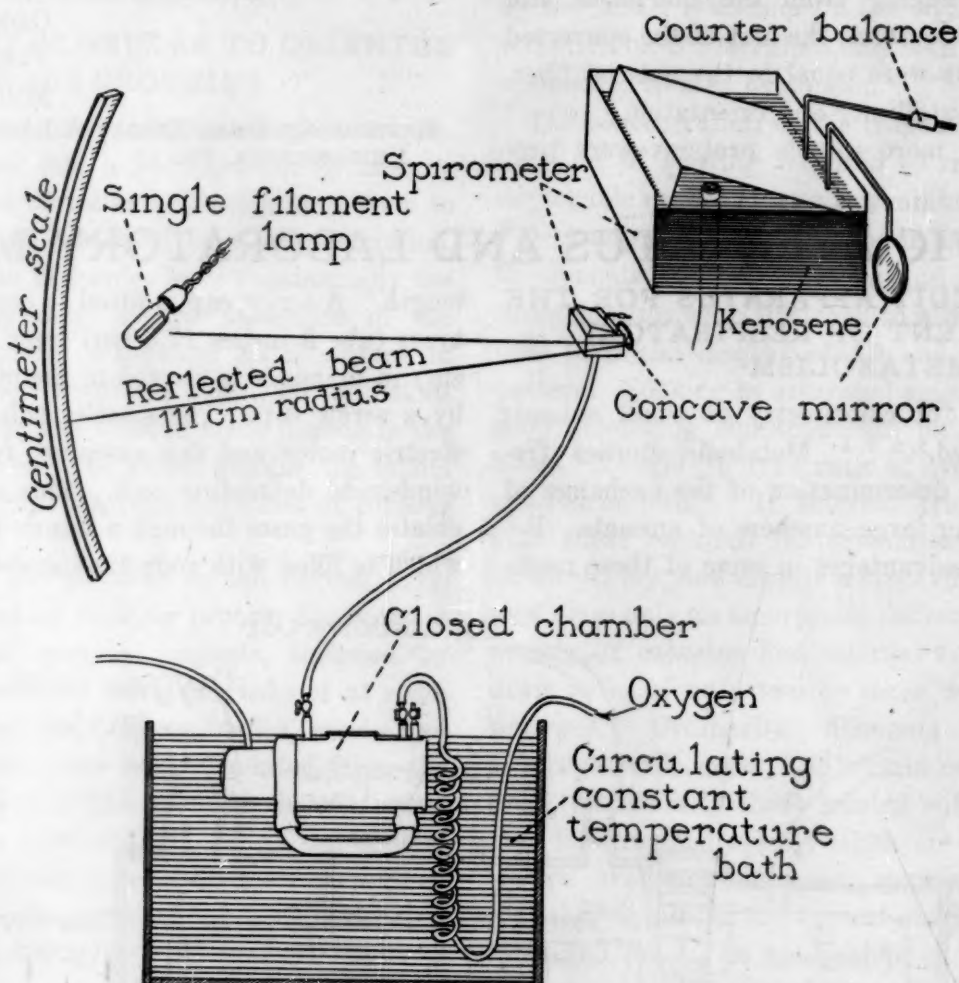


FIG. 2. Arrangement of metabolic chamber, spirometer and scale. Note that oxygen intake passes through a coil submerged in the constant temperature bath.

cursion of the light beam of 1 cm on the scale equals a change of volume of 1 cc within the respiratory chamber.

Half an hour before the first metabolic determination is made the unit is submerged, with the motor running, in a constant temperature bath thermostatically regulated to $\pm 0.10^\circ \text{C}$. In rat calorimetry the temperature was maintained at 28°C , as suggested by Benedict and MacLeod. Small restraint baskets of wire mesh were designed to limit the activity of the animal before and during a calorimetric determination.

After the rat (enclosed in a basket) has been placed in the chamber and submerged, oxygen is passed slowly into the system for five to seven minutes. One starts the experiment by closing the oxygen supply and the outlet stopcock and opening the stopcock to the spirometer. The deviation of the beam of light

paratus. The unit is inexpensive to build and could be made easily in the average machine shop.

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